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STRUCTURAL DESIGN CRITERIA

LIVE LOAD

Roof	20 PSF
Floor	150 PSF
Hoist	7½ tons, Net

SEISMIC LOAD

For structure as a whole	$F = 0.10\ W_{DL}$
Parapet Walls	$F = 1.00\ W_{DL}$
Other walls, normal to surface	$F = 0.20\ W_{DL}$

WIND LOAD

Based on 100 MPH $q = 26$ PSF

ALLOWABLE STRESSES:

Concrete

Footing, slab on grade - $f_c' = 2500$ PSI, $f_c = 1125$, $n = 10$

All others, $f_c' = 3000$ PSI, $f_c = 1350$, $n = 9$

Reinforcing steel, intermediate grade, deformed

$f_y = 40{,}000$ PSI $f_s = 20{,}000$ PSI

Structural steel, ASTM A-36 $f_y = 36{,}000$ PSI

Masonry Units, $f_m' = 800$ PSI $f_m = 267$ PSI

Increase in allowable stresses for combined loading

DL + LL + SEIS	33%
DL + LL + WIND	33%

ALLOWABLE SOIL PRESSURE

1200 PSF

DESIGN REFERENCES

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ONE WAY ROOF SLAB : $L = 13^{FT}$

DL 90
LL 20 } TL $110^{\#/\square'}$

$W = 13 \times 0.11 = 1.43^{K/FT}$

$M_o = {}^{1}/_{8} \times 1.43 = 2.32^{FTk/FT}$

$d \geq \sqrt{\frac{2320}{226}} = 3.2" < 7 - 1.5 = 5.5"$

$A_s \geq \frac{2.32}{1.44 \times 5.5} = 0.293^{\square"/FT} \sim \#4 @ 8"$ TRANSVERSE, BOTT.

$\frac{0.2}{100} \times 7 \times 12 = 0.17^{\square"/FT.}$, USE $\#3 @ 8"$ LONGITUD., BOTT.

CONC. WALL

$\frac{0.25}{100} \times 8 \times 12 = 0.24^{\square"/FT.} \sim \#4 @ 10"$ HORIZ. BARS

TRAVELLING HOIST BEAM : 12 I 31.8

$L = 12'$

$P = 20^{K}$ INCL. IMPACT.

$M = \frac{1}{4} \times 20 \times 12 = 60^{FTk}$

$f_b = \frac{60 \times 12}{36} = 20^{K/\square"}$

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STATIONARY HOIST BEAM : 18 I 54.7

$P = 20^{k}$ INCL. IMPACT, $L = 28'$

$M = \frac{1}{4} \times 20 \times 28 = 140$ FTK

$f_b = \frac{140 \times 12}{88.4} = 19.0\ ^{k}/_{\square''}$

TOP FLANGE STIFFENER : 10 [15.3

HORIZONTAL LOAD $\frac{1}{2} \times 0.2 \times 20^{k} = 2^{k}$

$M = \frac{1}{4} \times 2^{k} \times 28' = 14$ FTK

$f_b = \frac{14 \times 12}{13.4} = 12.5\ ^{k}/_{\square''}$

$\Delta = \frac{1}{48} \times \frac{2 \times 28^3 \times 12^3}{29000 \times 66.9} = 0.82''$

COLUMN : 16" × 24", 6 #9 VERT. BARS

ROOF	DL	$34.67 \times 18 \times 0.09$	$= 56.2$
CONC.	WALLS	$(30+13) \times 2 \times 9 \times \frac{8}{12} \times 0.15$	$= 77.4$
CONC.	BEAMS	$25 \times 1.33 \times 2 \times 0.15$	$= 10.0$
WALL	REVEAL	$(30+13) \times 2 \times 2 \times \frac{1}{12} \times 0.15$	$= 2.2$
COLUMNS		$4 \times 1 \times 0.5 \times 9 \times 0.15$	$= 2.7$
			148.5^{k}

HOIST LOAD $= 20^{k}$

ROOF L.L. $34.67 \times 18 \times 0.02 = 12.5^{k}$

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VERTICAL LOAD TO ONE COLUMN = N

$N = (148.5 + 12.5)\frac{1}{4} + 20 \cong 40 + 20 = 60^{k}$

TOTAL SEISMIC LOAD = H_B

$H_B = 148.5 \times 0.1 + 20 \times 0.1 = 14.85 + 2 \cong 17^{k}$

SEISMIC LOAD TO ONE COLUMN = H_c

$H_c = \frac{15}{4} + \frac{2}{2} = 3.75 + 1 = 4.75^{k}$

MOMENT AT TOP OF COLUMNS = M_T

$M_T = 4.75 \times 10 = 47.5^{FTk}$

MAX. $N = 60 + 2 \times 4.75 \times \frac{18}{12.67} = 60 + 13.5 = 73.5^{k}$

MIN. $N = \frac{148.5}{4} - 13.5 = 37 - 13.5 = 23.5^{k}$

$h' = 2h = 20^{FT.}$, $A_s = 6\ \#9 = 6.00\ \square''$

$p_g = \frac{6.00}{16 \times 24} = 0.0156$; $m = \frac{40}{0.85 \times 3} = 15.7$

$e_b = (0.67 \times 0.0156 \times 15.7 + 0.17)\,13.5 = 4.50''$

$R = 1.18 - \frac{0.9}{100} \times \frac{20}{0.3 \times 1.33} = 1.18 - 0.45 = 0.73$

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CASE I: $M = 47.5^{FTK}$, $N = 73.5^{k}$

$$e = \frac{47.5}{73.5} \times 12 = 7.75''$$

$$e_{b/e} = \frac{4.50}{7.75} = 0.58$$

$$R' = 1 - (1 - 0.73)\,0.58 = 1 - 0.157 = 0.843$$

$$D' = 0.14 \qquad C' = 2.14$$

$$0.843 \times M_{oe} = 47.5 - 0.14 \times \frac{73.5 \times 16}{12} = 47.5 - 13.7$$

$$0.843 \times M_{oe} = 33.8^{FTK}$$

$$A_{st} = \frac{2.14}{16} \times \frac{33.8}{0.843} = 5.36\ \square'' < 6.00\ \square''$$

CASE II: $M = 47.5^{FTK}$, $N = 23.5^{k}$

$$e = \frac{47.5}{23.5} \times 12 = 24.2''$$

$$e_{b/e} = \frac{4.50}{24.2} = 0.186$$

$$R' = 1 - (1 - 0.73)\,0.186 = 1 - 0.05 = 0.95$$

$$0.95 \times M_{oe} = 47.5 - 0.14 \times \frac{23.5 \times 16}{12}$$

$$0.95 \times M_{oe} = 47.5 - 4.4 = 43.1^{FTK}$$

$$A_{st} = \frac{2.14}{16} \times \frac{43.1}{0.95} = 6.05\ \square'' \sim 6.00\ \square''$$

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FOOTING PAD, LINE (B):

10'-0" × 14'-0" × 1'-4"

COLUMN LOAD		=	60
BLOCK WALL		=	5
FOOTING	10' × 7' × 1.33' × 0.15 K/CU.FT.	=	14
		Σ =	79 K

$$f_{SOIL} = \frac{79}{10 \times 7} = 1.13 \text{ K/□'}$$

$$\text{NET } f_{SOIL} = \frac{79-14}{10 \times 7} = 0.93 \text{ K/□'}$$

LONGITUDINAL

$$w = 0.93 \times 10' = 9.3 \text{ K/FT.}$$

$$W = 12.67 \times 9.3 = 118 \text{ K}$$

$$M_0 = \frac{12.67}{8} \times 118 = 187 \text{ FTK}$$

$$d \geq \sqrt{\frac{187000}{10 \times 179}} = 10.2" < 16-3 = 13"$$

$$A_s \geq \frac{187}{1.44 \times 13} = 10.0 \text{ □"} \sim 23\ \#6 \text{ LONGITUD. TOP BARS}$$

TRANSVERSE

$$W = 0.93 \times 7 \times 4 = 26 \text{ K}$$

CANTILEVER $M = 26^{K} \times 2' = 52 \text{ FTK}$

$$d \geq \sqrt{\frac{52000}{2 \times 179}} = 12" < 16-3.5 = 12.5$$

$$A_s \geq \frac{52}{1.44 \times 12.5} = 2.90 \text{ □"} \sim 4\ \#8 \text{ TRANSV. BOTT. BARS}$$

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FOOTING PAD, LINE (A):

WEIGHT = $7\times7\times1.33\times0.15 + 12\times4\times1.33\times0.15 + 8.83\times5\times1.33\times0.15$
= $9.80 + 9.60 + 8.83 = 28.23$
OR 14.1^{K} TO EA. COLUMN

AREA = $\frac{28.23}{1.33\times0.15} = 141\ \square'$ OR $70\ \square'$ TO EA. COL.

$f_{SOIL} = {}^{79.1}/_{70} = 1.13\ {}^{K}/_{\square'}$

NET $f_{SOIL} = {}^{65}/_{70} = 0.93\ {}^{K}/_{\square'}$

LONGITUDINAL BETWEEN COLUMNS:

$M_0 = \frac{1}{8}\times0.93\times12.67^2 = 18.6\ {}^{FTK}/_{FT.}$

Pos. $M = 18.6 - \left(0.93\times\frac{4.67^2}{2} + 0.93\times\frac{2.5^2}{2}\right)\frac{1}{2} = 12.1\ {}^{FTK}/_{FT.}$

$d \geq \sqrt{\frac{12100}{179}} = 8.3" < 13$

$A_s \geq 5\times\frac{12.1}{1.44\times13} = 3.24\ \square"\sim 12\#5$ TOP BARS

AT COLUMN A2:

$M = 5\times0.93\times2.5 = 11.6\ {}^{FTK}/_{FT}$

$A_s \geq 4\times\frac{11.6}{1.44\times12.5} = 2.60\ \square"\sim 10\#5$ BOTT. BARS

AT COLUMN A1:

$M = 4\times0.93\times2 = 7.5\ {}^{FTK}/_{FT.}$

$A_s \geq \frac{7.5}{1.44\times12.5} = 0.42\ {}^{\square"}/_{FT.}\sim \#4@5"$ BOTT. BARS

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